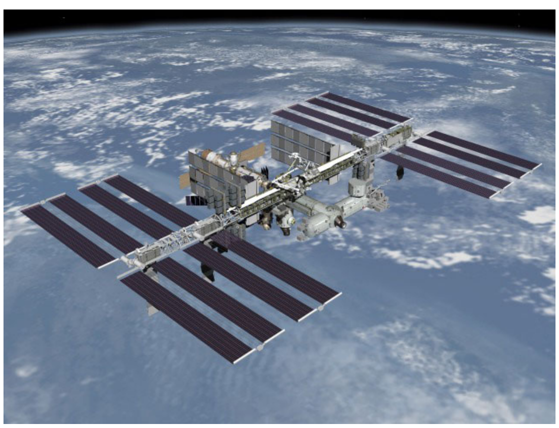
National Aeronautics and Space Administration

HAM It Up!
An Amateur Radio Overview

A Digital Learning Network Experience



Designed To Share

NASA Space Exploration

HAM It Up!
An Amateur Radio Overview

A Digital Learning Network Experience

National Aeronautics and
Space Administration

Designed To Share

The Vision for Space Exploration

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Digital Learning Network (DLN) Expedition

A DLN Expedition is a one time connection that allows students to experience NASA first-hand. Each expedition features an integrated educational package of grade-appropriate instruction and activities centered on a 50 minute videoconference. Students participate in a Question and Answer session with a NASA JSC education specialist or a NASA Subject Matter Expert.

SEQUENCE OF EVENTS

Pre-Conference Requirements
Online Pre-assessment
A pre-assessment tool is available to determine the students' level of understanding prior to the videoconference. Suggested answers are included.

Expedition Videoconference
Expedition Videoconference (About 45-60 minute conference)
Join the Digital Learning Network as we explore how astronauts on the International Space Station communicate using amateur, or HAM, Radio. Learn how amateur radio works, its purpose on the International Space Station, and how educators and students can participate in radio downlink events with astronauts through ARISS.

Post-Conference Requirements
Online Post-assessment
A post-assessment tool is available to determine changes in student levels of understanding.

NASA Education Evaluation Information System (NEEIS) Feedback Forms
Educator and student feedback forms are available online for all DLN events.

Expedition Overview

Grade Level   5-8

Focus Question
Communication is an essential component of a manned NASA mission. It is important for astronauts to stay in contact with Mission Control. One way astronauts keep in touch on the International Space Station is with amateur radio, or HAM radio. This method is also a means for the public to communicate with astronauts on board the Station. How does HAM radio work? How can educators and students participate in HAM radio connections?

Instructional Objectives
Students will:
- Understand the function and importance of amateur radio on the International Space Station through the videoconference event;
- Identify resources available for radio downlink participation through the videoconference event;
- Understand the importance of clear communication through pre- and post-activities;
- Demonstrate the limits of radio waves through pre- and post-activities.

National Standards
National Science Education Standards (NSES)
    Unifying Concepts
    Content Standard A – Science as Inquiry
    Content Standard B – Physical Science
    Content Standard E – Science and Technology
    Content Standard G – History and Nature of Science

National Council of Teachers of Mathematics (NCTM)
    Algebra
    Geometry
    Problem Solving
    Communication

International Technology Education Association (ITEA)
    Standard 1 –Characteristics and Scope of Technology.
    Standard 17 – Information and Communcation Technologies

National Standards

National Science Education Standards (NSES) (from www.nap.edu)

Science	Speaking Radioeese	DLN Connection	No Remote Control?
Unifying Concepts: Evidence, models, and explanations			X
Content Standard A: Science as Inquiry Abilities Necessary to do Scientific Inquiry	X	X	X
Content Standard B: Physical Science Transfer of Energy		X	X
Content Standard E: Science and Technology Abilities of Technological Design		X	X
Understanding about Science and Technology	X	X	
Content Standard G: History and Nature of Science Science as a Human Endeavor	X	X	X

Expected Student Behaviors

Unifying Concepts

Evidence, models, and explanations – *At the upper grades, the standard should facilitate and enhance the learning of scientific concepts and principles by providing students with a big picture of scientific ideas--for example, how measurement is important in all scientific endeavors.*

Content Standard A – Science as Inquiry

Abilities necessary to do scientific inquiry – *Students in grades 5-8 can begin to recognize the relationship between explanation and evidence. They can understand that background knowledge and theories guide the design of investigations, the types of observations made, and the interpretations of data. In turn, the experiments and investigations students conduct become experiences that shape and modify their background knowledge*

Content Standard B – Physical Science

Transfer of Energy – *The understanding of energy in grades 5-8 will build on the K-4 experiences with light, heat, sound, electricity, magnetism, and the motion of objects. In 5-8, students begin to see the connections among those phenomena and to become familiar with the idea that energy is an important property of substances and that most change involves energy transfer.*

Content Standard E – Science and Technology

Abilities of Technological Design – *Students should, through the experience of trying to meet a need in the best possible way, begin to appreciate that technological design and problem solving involve many other factors besides the scientific issues.*

Understanding about Science and Technology – *Students in grades 5-8 can begin to differentiate between science and technology, although the distinction is not easy to make early in this level. One basis for understanding the similarities, differences, and relationships between science and technology should be experiences with design and problem solving in which students can further develop some of the abilities introduced in grades K-4.*

Content Standard G – History and Nature of Science

Science as a Human Endeavor – *Students will develop an understanding that science is very much a human endeavor, and the work of science relies on basic human qualities, such as reasoning, insight, energy, skill, and creativity--as well as on scientific habits of mind, such as intellectual honesty, tolerance of ambiguity, skepticism, and openness to new ideas.*

National Council of Teachers of Mathematics (NCTM) (from standards.nctm.org)

Mathematics	Speaking Radioeese	DLN Connection	No Remote Control?
Algebra Understand patterns, relationships, and functions *(see student behaviors for benchmarks)*	X		
Geometry Analyze characteristics and properties of two- and three-dimensional geometric shapes and develop mathematical arguments about geometric relationships *(see student behaviors for benchmarks)*	X		
Specify locations and describe spatial relationships using coordinate geometry and other representational systems *(see student behaviors for benchmarks)*	X		
Problem Solving All benchmarks	X		
Communication All benchmarks	X		

Expected Student Behaviors

Content Standard – Algebra

Understand patterns, relationships, and functions
(3-5) *Students should describe describe, extend, and make generalizations about geometric and numeric patterns.*
(6-8) *Students should represent, analyze, and generalize a variety of patterns with tables, graphs, words, and, when possible, symbolic rules.*

Content Standard – Geometry

Analyze characteristics and properties of two- and three-dimensional geometric shapes and develop mathematical arguments about geometric relationships
(3-5) *Students should identify, compare, and analyze attributes of two- and three-dimensional shapes and develop vocabulary to describe the attributes.*
(6-8) *Students should precisely describe, classify, and understand relationships among types of two- and three-dimensional objects using their defining properties.*

Specify locations and describe spatial relationships using coordinate geometry and other representational systems
(3-5) *Students should describe location and movement using common language and geometric vocabulary.*
(6-8) *Students should use coordinate geometry to represent and examine the properties of geometric shapes.*

Content Standard – Problem Solving

(All grades) *Students should build new mathematical knowledge through problem solving, solve problems that arise in mathematics and in other contexts, apply and adapt a variety of appropriate strategies to solve problems, and monitor and reflect on the process of mathematical problem solving.*

Content Standard – Communication

(All grades) *Students should organize and consolidate their mathematical thinking through communication, communicate their mathematical thinking coherently and clearly to peers, teachers, and others, analyze and evaluate the mathematical thinking and strategies of others, and use the language of mathematics to express mathematical ideas precisely.*

International Technology Education Association (ITEA)(from www.iteaconnect.org)

Technology	Speaking Radioeese	DLN Connection	No Remote Control?
Standard 1: The Characteristics and Scope of Technology (3-5) D: Tools, materials, and skills are used to make things and carry out tasks (6-8) F: New products and systems can be developed to solve problems or to help do things that could not be done without the help of technology		X X	
Standard 17: Information and Communication Technologies (3-5) F: Communication technology is the transfer of messages among people and/or machines over distances through the use of technology (6-8) J: The design of a message is influenced by such factors as the intended audience, medium, purpose, and nature of the message		X X	

Expected Student Behaviors

Standard 1 – Students will develop an understanding of the characteristics and scope of technology.

(3-5) Tools, materials, and skills are used to make things and carry out tasks – *When students observe how various things are made, grown, or used, they should begin to see that different processes and techniques are used.*

(6-8) New products and systems can be developed to solve problems or to help do things that could not be done without the help of technology – *Students in the middle-level grades will explore in greater detail the scope of technology. From personal and classroom experience, students will be familiar with specific ways in which technology is dynamic.*

Standard 17 – Students will develop an understanding of and be able to select and use information and communication technologies

(3-5) Communication technology is the transfer of messages among people and/or machines over distances through the use of technology – *Students at this grade level should be given various opportunities to use information and communication tools in order to experience firsthand how technology can be used to enhance the communication process.*

(6-8) The design of a message is influenced by such factors as the intended audience, medium, purpose, and nature of the message – *Students should be provided with numerous opportunities to use information and communication systems for assistance in solving problems, making better decisions, and communicating with others.*

Expedition Videoconference Guidelines

Audience Guidelines
Teachers, please review the following points with your students prior to the event:
Videoconference is a two-way event. Students and NASA presenters can see and hear one another.

Students are sometimes initially shy about responding to questions during a distance learning session. Explain to the students that this is an interactive medium and we encourage questions.

Students should speak in a loud, clear voice. If a microphone is placed in a central location instruct the students to walk up and speak into the microphone.
Teacher(s) should moderate students' questions and answers.

Teacher Event Checklist

Date Completed	Pre-Conference Requirements
	Print a copy of the module.
	Have the students complete the pre-assessment.
	Email questions for the presenter. This will help focus the presentation on the groups' specific needs.
	Review the Audience Guidelines, which can be found in the previous section.
	Day of the Conference Requirements
	The students are encouraged to ask the NASA presenter qualifying questions about the Expedition.
	Follow up questions can be continued after the conference through e-mail.
	Post - Conference Requirements
	Have the students take the Post-Assessment to demonstrate their knowledge of the subject.
	Use the provided rubric as guidelines for content and presentation criteria.
	Teacher(s) and students fill out the event feedback.

Expedition Videoconference Outline

Introduction to Expedition Videoconference

Join the Digital Learning Network as we explore how astronauts on the International Space Station communicate using amateur, or HAM, Radio. Learn how amateur radio works, its purpose on the International Space Station, and how educators and students can participate in radio downlink events with astronauts through ARISS.

<u>Outline for Video Conference</u>

Welcome
Introduction
Define Amateur Radio
How HAM Radio Works
How World Uses Amateur Radio
How NASA uses Amateur Radio aboard ISS
How Educators and Students use Amateur Radio
How to Connect with the ISS
ARISS Connection Demonstration
Online Resources
Q&A
Good-Bye

Pre-Conference Requirements

Pre-Assessment

A week before the event, students will need to take the pre-conference assessment. This short assessment will provide useful background information for the presenters to prepare for the videoconference.

Pre-Conference Assessment Questions

1. What is sound?
2. How does sound travel?
3. List ways we can communicate with people on Earth.
4. List ways astronauts can communicate to Earth.
5. What is HAM radio?
6. Why is communication an important factor of NASA manned missions?
7. What is the electromagnetic spectrum?
8. Define radio wave.
9. What is a wavelength?
10. Heinrich Hertz is known for what? What is his legacy?

Suggested Answers to Pre and Post Assessment Questions:

1. What is sound?
   Sound is vibration that passes through a solid, liquid, or gas. Certain frequencies of sound can be detected by the human ear.

2. How does sound travel?
   Sound travels in waves.

3. List ways we can communicate with people on Earth.
   Answers will vary.

4. List ways astronauts can communicate to Earth.
   Radio and email are the most common forms of communication to the ground.

5. What is HAM radio?
   HAM radio is another name for amateur radio. The word “ham” refer to the radio operators.

6. Why is communication an important factor of NASA manned missions?
   Answers will vary.

7. What is the electromagnetic spectrum?
   The electromagnetic spectrum is the range of all possible electromagnetic radiation (Students may include UV, infrared, visible, etc).

8. Define radio wave.
   A radio wave is a electromagnetic wave occurring on the radio frequency portion of the electromagnetic spectrum.

9. What is a wavelength?
   A wavelength is the distance between repeating units of a wave.

10. Heinrich Hertz is known for what? What is his connection to sound?
    Hertz is known for his work on the electromagnetic theory of light. In honor of his work in the physics field, the SI unit for frequency is named Hertz.

Pre-Conference Activities

Article: Hamming It Up on the ISS

You see it on television: NASA officials contact astronauts on the Space Station through radio hookups. There's another way to keep in touch with crewmembers, though, and anyone with a ham radio system can participate. And just for the record, the conversations don't start with "Breaker, breaker one-nine."

Amateur radio, also called ham radio, has become the fun way for average folks to communicate with Space Shuttle and Space Station astronauts. Anyone with a scanner can listen to the communications that take place between Earth and space, and if you have a transmitter, you can get in on the conversations.

"The whole point is to spark an interest in science and technology," says Frank Bauer, chief of the Guidance and Navigation Control Center at Goddard Space Flight Center in Maryland. "Communicating with ham radio started with the Space Shuttle program in 1983, and by the mid 80s, we had several school group interaction activities going."

"This opens new doors for access to the astronauts," Bauer says. "Before, only the president or other VIPs could talk with the astronauts while they were in space. Now with an amateur radio license, you can talk too. The ham radio project was the first effort to allow astronauts to talk with the general public."

To talk with the astronauts, you'll need to know several important bits of information, says Paul Dumbacher, a propulsion test engineer at Marshall Space Flight Center in Alabama, who also enjoys ham radio. Everything you'll need to know to get started is listed at the Amateur Radio on the International Space Station (ARISS) web site (http://ariss.gsfc.nasa.gov/).

"The important things to know are when the Space Station will be over your location, what frequency the astronauts transmit on, and what the crew's schedule is," Dumbacher says. "It doesn't matter if ISS is passing overhead during daylight hours, because you don't need to see the craft. The important thing is to take advantage of the small window of opportunity you have to communicate with them. ISS is overhead for only about 10 minutes at a time in any given area, so you have to be on the ball."

Information at the ARISS web site will tell you the call signs of the astronauts, so you'll know whom you're listening to, Dumbacher says. And taking the time to learn a bit of basic amateur radio lingo will help you understand the proceedings.

"Conversations begin with the sender's call signs and then a signal report," Dumbacher says. "Then someone is asked what their QTH is; that's short for your location. If an astronaut says, "QRZ," that means he's opening the conversation up for the next interested participant. It takes a while to learn the language of ham radio, but it's a wonderful opportunity to make contact with a piece of history. You can see NASA on TV, look at maps, and they don't seem real. But to go outside and look up and see the Space Station or hear them talking on the radio. That's real. To talk with people on a man-made object launched by a rocket is all very amazing."

While individuals can monitor Space Station transmissions from home, school groups can make it a class project and work closely with ham radio operators and NASA staff members to schedule a conversation with the astronauts. The ARISS project was started with that goal in mind: classes of students interacting directly with astronauts through ham radio linkups.

"There are many options open to contacting the astronauts through amateur radio," Bauer says. "Sometimes schools can't contact the ISS from their location. They can use a program called Tele-bridge, which is a phone bridge set up to communicate from telephone to short wave radio. We've had groups in Australia and South Africa use Tele-bridge to make their connections."

It's a challenge to be sure the school group is ready to communicate at the precise moment the Space Station is overhead, Bauer says. "There's a 10-minute window you have to jump on. The equipment can't be too simple or too complex, you have to have the orbit information right, and the children have to be prepared to conduct their conversations efficiently. But it's all worth it when it works."

The actual contact with the astronauts is the top of the pyramid, Bauer says. It's the peak experience. "But the foundation under that pyramid peak is the remarkable part. The learning required to prepare for this contact-antenna, radio, orbit, press releases, geography, trail and error-it all shows the children how demanding this process is, and how much knowledge is required for success."

It's a living example of why mathematics and science are good things. "It shows practical use of formulas," Dumbacher says. "Students learn about complex ideas like Doppler Shift and trajectory paths. It shows that even addition and subtraction get you to important points. Science matters; without science we wouldn't have ISS; we wouldn't understand weather; we wouldn't understand basic functions of everyday life. And there's no better way to learn it than by doing it."

If you get the opportunity to make contact with Shuttle or Space Station astronauts, Dumbacher has one bit of advice. "Be sure to get a QSL card. That's a card NASA will send you proving that you talked to an astronaut. There's information about getting it on the ARISS web site. You'll want to be able to put that up on your bulletin board and tell everyone."

Courtesy of NASA's Space Operations Mission Directorate

Speaking Radioeese

Teacher Sheet(s)

Objective: State oral directions clearly and correctly. Construct a structure using oral directions.

Level: 5-8
Subjects(s): Science, Mathematics
Prep Time: Less than 10 minutes
Duration: 30 - 45 minutes
Materials Category: General Classroom

National Education Standards
Science: Science as Inquiry, Technology, History and Nature of Science
Math: 4a, 9a, 8a 18, 20

Materials:
- Pattern blocks (or any type of building blocks)
- One manila folder (or hard bound book)
- Two popsicle sticks or tongue depressors, or two cardboard centers from paper towel rolls
- Aluminum foil pieces
- Books or short stories about space (one for each group)
- Optional: 2.5 cm Styrofoam ball for top of microphone

Pre-Lesson Instructions:
None

Background Information:
Communication is an important, vital, and necessary part of all space flights. The members of each Shuttle and International Space Station crew must talk with each other and with workers on the ground to carry out the many functions needed to fly the spacecraft and rendezvous with other objects in space. Mission Control must keep in constant contact with other personnel at sites around the world to monitor the progress of the spacecraft as it orbits Earth. Teachers and students in schools communicate with each other to learn more about space travel and how it is changing our lives each and every day. The astronauts use a radio on board the Shuttle on frequencies used by amateur (or "ham") radio operators to communicate directly with large groups of students. For all operations, Earth stations listen to the input or receiving frequency and transmit only when the Shuttle is in range of the ground station and the astronauts are using the radio. Students listen for any instructions from the astronauts as to the output or transmitting frequency before transmitting to avoid interfering with other radio users. They practice using a

microphone correctly just as the astronauts must do during their training for the mission.

Guidelines:

1. Read the article "Hamming It Up On ISS."

2. When students, astronauts, and ham radio operators use the amateur radio to talk with people next door, all over the world, or orbiting in space, they use a microphone. Explain to students that they are going to make a "pretend" microphone that will be used when practicing how to talk correctly over the radio. Give each student one popsicle stick, tongue depressor, or cardboard center from a paper roll, and a large piece of aluminum foil. Demonstrate how to wrap the foil around the top of the stick in a ball so it looks like the top of a microphone. A 2.5 cm Styrofoam ball may be placed on top of the stick and covered with one layer of foil instead.
3. Model for students how to hold the microphone in one hand, not too close to the mouth. Say the names of the nine planets to demonstrate how to speak slowly and distinctly. Be sure to tell the students each time they have finished speaking that they are to say "over." This is the word used by amateur radio operators to signify they have finished their transmission and others may now talk. Allow time for students to make a microphone and to practice speaking with their teammates. Circulate among the students and make sure they are holding the microphone correctly and speaking correctly. Have one student say the nine planets, stopping wherever they wish and saying, "over." The teammate must begin speaking into the microphone saying the next planet, and when finished, saying, "over."

Example: "Mercury, over." "Venus, Earth, Mars, over." "Jupiter, Saturn, over."

After the initial practice time, tell students they are going to read to their teammates. Each student in the team will read a paragraph or page from a book or story while holding the microphone correctly. Each time they have finished reading, they must say, "over" before the next person can begin. Teammates are not to begin until they hear the word "over."

When the class has had sufficient practice time, have them put down the microphones and show them the pattern blocks. Ask students to tell you what they know about each shape. Have students draw each shape or write the names of each block on the Student Sheet as you display them to the class (square, triangle, two parallelograms, hexagon, trapezoid, etc.).

HINT: For older students, use one block of each shape. For younger students, pick only two or three.

Explain to students that when astronauts are in space, they talk to the ground through a Capsule Communicator (CAPCOM). This is another astronaut located in the Mission Control Center (MCC) at Johnson Space Center (JSC) in Houston. All information and directions are relayed to the astronauts on orbit through the CAPCOM.

4. Tell students that one member of each team will be taking the role of astronaut and the other member will be CAPCOM. Show students the blocks you are going to use and ask them to get those blocks from their piles.

5. Model the activity by taking the role of CAPCOM and having all students become astronauts. Build a structure behind a manila folder so students cannot see the structure. Make sure students understand spatial perspective and orientation of left and right.

   After you have built a structure, use your microphone to give detailed instructions so the students will be able to replicate what you have built. Remember to say "over" after each set of instructions.

6. After the students have completed building, compare the structures. Discuss which words you used that were helpful to them in building. Have students make a list of these words on the Student Sheet.

7. Students will now be given time to build with their partners. They will build many times, switching roles each time, and using the microphone each time. Circulate among the class to monitor and assist.

8. When building has been accomplished many times, have students write directions on the Student Sheets. These sheets can be taken up for assessments. They can also be used as written instructions for other students to build structures.

Discussion/Wrap-up:
Discuss the importance communication played in building the structure. How would this be important in space flight? How will this be important in building the International Space Station?

Extensions:
- Have students use two-way radios. Each student should be in a different room or location. Build the structures by communicating the directions correctly over the radio.
- Have students write their own scripts for a play describing a problem on the Shuttle or International Space Station. The problem would necessitate the building or repairing of some piece of equipment used by astronauts during a mission. Students could perform the play. If video equipment is available, students could set up their own production as a newscast and show the production to other classes.
- Have students use the microphones each time they talk for an entire day.

Speaking Radioeese

Student Sheet(s)

Name: ____________________________________

Names / Shapes of Pattern Blocks

Directions for building my structure:

1.
2.
3.
4.
5.
6.
7.
8.
9.
10.
Communications are important in space flight because:

Post-Conference Activities

Online Post-Assessment

After the event students will need to take the post-conference assessment. (These questions are the same questions used in the pre-assessment.) The short assessment will help us measure student learning and identify any changes that need to be made in future programs.

Post-Conference Assessment Questions
Grades 5-8

1. What is sound?
2. How does sound travel?
3. List ways we can communicate with people on Earth.
4. List ways astronauts can communicate to Earth.
5. What is HAM radio?
6. Why is communication an important factor of NASA manned missions?
7. What is the electromagnetic spectrum?
8. Define radio wave.
9. What is a wavelength?
10. Heinrich Hertz is known for what? What is his legacy?

No Remote Control?

Teacher Sheet(s)

Objective: To demonstrate that radio waves cannot pass through certain materials.

Level: 5-8
Subjects(s): Science
Prep Time: Less than 10 minutes
Duration: 30 - 45 minutes
Materials Category: Common Household

National Education Standards
Science: Unifying Concepts, Science as Inquiry, Physical Science, Technology, History and Nature of Science

Materials:
- Television with remote control
- Tape
- Scissors
- Aluminum foil
- Yarn (6 feet long), any color
- Student Sheets

Pre-Lesson Instructions:
This lesson requires a television set with a remote control. Have extra batteries for the remote control on hand in case the batteries run out of power.
Students may want to work in pairs or small groups for the activity involved in this lesson.

Background Information:
The Space Amateur Radio Experiment (SAREX) has been included on many Shuttle flights and will be on the International Space Station. In order for SAREX to be operational, a signal must connect a radio on Earth to the Shuttle orbiter or International Space Station. The signal cannot be seen by the human eye, but must be present for an astronaut or a student to talk or to be heard. This signal is called a radio wave. Radio waves are a form of energy. They go from the radio on Earth to a land-based antenna. The signal is then transmitted to an antenna located in the window of the orbiter, then to the SAREX system inside the orbiter. This process is reversed as the signal is sent back to Earth. Many school children over the years have been able to participate in or listen to conversations to and from space using this system.

Another important use for radio waves is to send signals to distant exploration space probes. These signals are sent and received by the Deep Space Network (DSN). The DSN is the system that NASA uses to communicate with its many spacecraft exploring other worlds. It is the largest and most sensitive scientific telecommunications system in the world. The DSN is a collection of three communications complexes that support interplanetary spacecraft missions. Each complex has several antennas with diameters ranging in size from 26 meters (85 feet) to 70 meters (230 feet). One of the complexes is at Goldstone in California's Mojave Desert; another is near Madrid, Spain; and the third is near Canberra, Australia. This placement puts the three facilities about 120 degrees around the world from each other, allowing constant contact with spacecraft as the Earth rotates. The antennas can be steered toward a particular direction with very high accuracy. The two-way communications system between the ground and the spacecraft makes it possible to receive telemetry data from spacecraft and determine their position and velocity and to transmit commands back to the spacecraft. The DSN is operated by NASA's Jet Propulsion Laboratory, which also operates many of the agency's interplanetary spacecraft missions.

This activity involves the entire class. A television will be used since it is an item readily accessible in most schools. Most television remote controls use infrared signals. In this activity, the signal will be blocked by aluminum foil, a very light, man-made metal. Students will then have the opportunity to experiment with different materials to see how they affect the radio signal.

Guidelines:

1. Point out the television and remote control to the students. Ask students what the function of the remote control is. Students list individual observations of the properties of the remote control on the Student Sheet.

2. Take examples of student observations from volunteers, and place them on the board.

3. Ask a student to turn on the television. List individual predictions on Student Sheet on the board as to what will happen when another student points the remote control at the television and pushes the channel button. Let a student demonstrate by changing channels.

4. Ask what the students think caused the remote control to turn on the television. Guide them to understand that the television receiving eye received the signal that caused the channel to change. Ask two students to take the yarn and show the path the signals took. Have them hold the yarn in place. (Guide them to the receiving eye on the television, not the screen.) Ask the class for the definition of a receiving eye. Check the list of observations made on the Student Sheet and the board. If the term receiving eye is not there, add it to the list.

5. Ask a student to tape a piece of aluminum foil over the receiving eye on the television. Have students write predictions on the Student Sheet as to what will happen when a student tries to change the channel again. Elicit responses. NOTE: Aluminum is a very lightweight, nonmagnetic metal. The signal sent out from the remote control device is reflected by this metal.

6. Have a student try to change channels. Discuss what has happened. Ask the two students with the yarn if they can show the path the signal took this time. Lead them to stretch the yarn from the remote to the receiving eye and back out again showing the signal did not get through, but was reflected instead.

Discussion/Wrap-up:

- Have students write their observations of what has happened on the Student Sheet. Ask for volunteers to read their responses to the class. Discuss the observations.
- Repeat the activity using other materials from around the classroom in place of the aluminum foil. This could include wax paper, notebook paper, cardboard, wood, rubber, etc. Have students make predictions prior to the testing with the remote control.
- Collect Student Sheets for assessment.

Extensions:

- Have the students use remote-controlled cars or two-way radios to show the presence of radio waves. Experiment with the different variables such as the distance the waves travel. How far away can the car be controlled? How far away can you hear another person?
- Have students try pointing the remote control at different angles from the television. Does the control need to be pointed at the television? What happens when it is pointed in another direction?

No Remote Control?

Student Sheet(s)

Name: ____

List observations of television	List observations of remote control
Predictions	
Predictions for aluminum foil	What have you learned?

NASA Education Evaluation Information System (NEEIS)

Please complete an online evaluation form to provide feedback on the NASA Challenge.
Feedback from you and a few of your students would be appreciated.

http://dln.nasa.gov/dln/content/feedback/

National Aeronautics and Space Administration

NASA Digital Learning Network

presents

Certificate of Completion

to

____

for

HAM It Up!

______________________________ ______________

Instructor *Date*

Vocabulary

Amplitude Modulation (AM): a technique used in electronic communication, most commonly for transmitting information via a radio carrier wave; works by varying the strength of the transmitted signal in relation to the information being sent.

ARISS: acronym for Amateur Radio on the Internation Space Station; a volunteer program which inspires students, worldwide, to pursue careers in science, technology, engineering and math through amateur radio communications opportunities with the International Space Station (ISS) on-orbit crew.

Electromagnetic Spectrum: the range of all possible electromagnetic radiation; the "electromagnetic spectrum" (usually just spectrum) of an object is the characteristic distribution of electromagnetic radiation from that object.

Energy: strength or power to work or be active; force; vigor; the power of certain forces of nature to do work.

Frequency: a measure of the number of occurrences of a repeating event per unit time.

Frequency Modulation (FM): a technique used in telecommunications; conveys information over a carrier wave by varying its frequency.

HAM Radio: also known as amateur radio

Hertz: the SI unit for measuring frequency; named in honor of physicist Heinrich Hertz.

International Space Station: a laboratory orbiting the Earth; a joint mission with the space programs of 16 countries, including the United States.

Radio Waves: electromagnetic waves occurring on the radio frequency portion of the electromagnetic spectrum.

Sound Waves: the vibration transmitted through a solid, liquid, or gas; particularly, sound means those vibrations composed of frequencies capable of being detected by ears.

Wavelength: a measure of a light; the peak to peak distance one vibration of an electromagnetic wave

Resources

NASA
For information on exploratory missions, manned spaceflight, and more, please visit this website.
www.nasa.gov

NASA Kids
For activities, games, stories and more, visit this website specifically designed for kids that are interested in space and NASA.
http://www.nasa.gov/audience/forkids/home/index.html

American Radio Relay League (ARRL)
http://www.arrl.org

Radio Amateur Satellite Corporation (AMSAT)
http://www.amsat.org

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